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April 8, 1993

Mr. Wayde M. Hartwick  
United States Environmental Protection Agency  
Region V, HSRL-6J  
77 West Jackson Boulevard  
Chicago, Illinois 60604

Re: Transmittal of Treatability Study Reports  
American Chemical Services (ACS) NPL Site  
Griffith, Indiana

Dear Mr. Hartwick:

Enclosed are five copies of the low temperature thermal treatment (LTTT), soil vapor extraction (SVE), and bioventing bench-scale treatability study reports utilizing waste and soil samples from the American Chemical Services (ACS) site. The purpose of these bench-scale treatability studies was to evaluate the feasibility of these technologies to successfully treat the waste and contaminated soil matrices at the ACS site, and evaluate the potential for these technologies to achieve the clean-up levels listed in the Record of Decision (remediation levels) for the ACS site.

These treatability study reports show that the technologies can successfully from a bench-scale perspective treat the ACS waste and contaminated soil matrices as was expected based the ACS Feasibility Study report. LTTT typically achieved >99.9% removal of volatile organic compounds (VOCs) from the waste samples used in the treatability study. The SVOC removals ranged from >77.2% to >99.9%. Polychlorinated biphenyls (PCB) removals ranged from >98.6% to >99.3%.

The removals of total VOCs from the contaminated soil samples using SVE ranged from 99.3% to > 99.9%, but total SVOC removal was approximately 52 %. Bioventing with nutrient amendments improved the SVOC removals to between 61.5% and 88.5%. The VOC removals for bioventing ranged up to >99.9%. A more detailed summary of the treatability studies is included with this letter as Attachment A.

The LTTT treatability study results for the waste matrix indicate that the remediation levels for VOCs and PCBs were achieved, while SVOCs were reduced to the analytical detection limits. Based upon the LTTT treatability study results, however, it is not possible to prove that all of the remediation levels for SVOCs were achieved due to matrix interferences limiting the sensitivity of the methodology. The results of the SVE and bioventing treatability studies for the





contaminated soil samples indicate that the remediation levels for VOCs were achieved.

Based upon the SVE treatability study results, reductions in SVOC concentrations were realized. However, SVOC remediation levels were not achieved in those instances where the initial concentrations exceeded their respective remediation levels. It is not possible to prove that many of the SVOC remediation levels were achieved using bioventing or SVE due to matrix interferences limiting the sensitivity of the methodology. The analytical method detection limits utilized were consistent with the United States Environmental Protection Agency Contract Laboratory Protocol, but there were also matrix interferences due to the concentration of organic material remaining in the treated samples which elevated the detection limits. Analytical detection limits will be an issue at full scale implementation of these technologies.

Warzyn and Conestoga-Rovers & Associates (CRA) are convinced that LTTT of the waste matrix and SVE/bioventing for the contaminated soil matrix are the appropriate technologies, but believe that due to uncertainties in scale-up, the complex nature of the matrices and high levels of contaminants at the site, it may not be possible to achieve or demonstrate achievement of each of the individual remediation levels. Warzyn and CRA have previously questioned the methodology used to set the remediation levels. Unless adjustments are made to certain remediation levels, or a technical infeasibility waiver is granted, where appropriate, as part of the CERCLA review process, the remediation technologies selected in the ROD, which appear well suited to address the site contaminants based on the treatability study results, will not meet each of the prescribed cleanup criteria.

Warzyn and CRA look forward to meeting with you later this month to discuss the results of the treatability study and your thoughts on our request to modify the approach to the calculations of the remediation levels.

Sincerely,

WARZYN INC.

Martin J. Hamper  
Project Manager

Mark S. Rothas  
Senior Project Engineer

Enclosures: Attachment A  
LTTT Treatability Report (5)  
SVE Treatability Report (5)  
Bioventing Treatability Report (5)

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# A

## SUMMARY OF TREATABILITY STUDY RESULTS AMERICAN CHEMICAL SERVICES SITE

### LTTT TREATABILITY STUDY

A low temperature thermal treatment (LTTT) treatability study was performed by Canonie Environmental Services Corp. (Canonie) on three waste samples from the American Chemical Services (ACS) site. The three samples included two from the Off-Site Containment Area and one from the On-Site Containment Area. The On-Site Containment Area sample and one Off-Site Containment Area sample were spiked with selected contaminants in order to achieve higher concentrations considered to be more representative of reasonable worst case levels based on the RI data. The Canonie treatability study system operated at a maximum temperature of 1100°F and a residence time of 30 minutes. The treatability study samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs) before and after treatment. The following summarizes the results of the LTTT treatability study (Tables 1-7).

- The LTTT treatability study results demonstrated that the ACS buried waste can potentially be treated to the greater of the remediation levels or the analytical detection limits under the optimum conditions that exist at the bench-scale. Residual non-volatile organic material is expected to remain in the treated waste at percentage levels based on the total organic carbon (TOC) results for the coked solids.
- For all three test runs, significant removal efficiencies were achieved for VOCs, SVOCs, and PCBs. For compounds with initial concentrations in excess of site remediation levels, the final concentrations were reduced to below the greater of the remediation level or the analytical detection limit. However, residual levels of VOCs were detected in the



treated waste samples. Low parts per billion concentrations of several VOCs were detected in the treated waste for one of the test runs. Two to three VOCs were detected in the treated waste for the other two test runs, but the detection limits were elevated. SVOCs and PCBs were below analytical detection limits in the treated waste for all three test runs.

- The initial concentrations and types of VOCs, SVOCs, and PCBs are considered representative for the On- and Off-Site Areas. The addition of the spiking solution to two of the test samples was designed to simulate a waste matrix for treatability study purposes. Because of the reasons discussed in the Canonie report, the spiking concentrations were not reflected in the initial concentrations based on the analytical data. It is believed that the treatability tests for the two spiked samples were representative of reasonable worst case concentrations for the waste matrix, even though the analytical data cannot be used to support this presumption.
- The analytical detection limits exceeded the remediation levels in two of the test runs for the VOCs vinyl chloride, carbon tetrachloride, and 1,1,2,2-tetrachloroethane and in all three test runs for the SVOCs bis(2-chloroethyl) ether, hexachlorobutadiene, 2,4- and 2,6-dinitrotoluene, hexachlorobenzene, pentachlorophenol, and carcinogenic polynuclear aromatic hydrocarbons (PAHs). The analytical detection limits were either consistent with the United States Environmental Protection Agency Contract Laboratory Program Method Detection Limits (CLP), or due to matrix interferences caused by residual high boiling point organic materials remaining in the waste following treatment.
- Residual non-volatile organic material remained in the treated waste based on the total organic carbon (TOC) results for the coked solids and matrix interferences observed during the VOC and SVOC analytical testing.

The following factors associated with the effectiveness and operation of a full-scale LTTT system were not evaluated as part of a bench-scale treatability study. These conditions will be evaluated during the Remedial Design and Remedial Action (RD/RA) phases of this project.

- The treatability study results may not be applicable to worst case maximum concentrations in the waste matrix that could be encountered if excavated material is not adequately homogenized prior to treatment. It is believed that the unspiked composite waste sample can be considered representative of weighted average contaminant



concentrations (i.e., concentrations following blending of the excavated soil) in the defined waste areas for the locations and depths sampled in the Off-Site Containment Area, which were significantly lower than the maximum concentrations for individual contaminants measured during the ACS Remedial Investigation (RI). The spiked samples are believed to be representative of the waste matrix (minus absorption effects).

- Because of the composition of the waste matrix, potential material handling problems will likely have to be addressed during the design phase. The "tackiness" of the sludge matrix, as well as the presence of free liquids, could pose volatilization, blending, handling, and conveyance problems during full-scale operation. The presence of sludge and free liquids was noted in the treatability study samples during sampling and analysis activities (e.g., one sample separated into distinct liquid and solid phases which could not be blended together during the analysis of initial concentrations).
- Depending on the design of a specific LTTT system, volatilized organics can either be treated in the air phase or condensed for off-site treatment or disposal. The economics of treating or disposing of a condensed residual wastestream versus operation of an air treatment system will have to be weighed during the design phase prior to selecting a full-scale LTTT system. The Canonic treatability study system condensed the volatilized organics for collection and off-site treatment. This data can be used in future economic evaluations of LTTT system operation.
- LTTT units are typically designed to handle TOC levels of 1% to 10%. The Canonic system is reportedly capable of treating up to 10% TOC. Because of the high TOC levels in the waste matrix across the site, which were reflected in the treatability study samples, soil blending will likely be required to treat the waste matrix at the Site.
- The high moisture levels in the treatability study samples (18.6 to 29.2%) believed to be representative of site conditions, will likely result in slow processing rates.

### **SVE TREATABILITY STUDY**

A soil vapor extraction bench-scale treatability study was performed by Vapex Environmental Technologies, Inc. (Vapex) on two contaminated soil samples from the ACS site. The two soil samples included one each from the Off-Site Containment and Treatment Lagoon/Still Bottoms Areas. A third soil column was run using a lower air flowrate to evaluate potential mass transfer limitations.



The laboratory soil column studies exchanged from 3,000 to 11,000 air pore volumes. The soil samples were analyzed for VOCs before and after the study. One of the three samples was also analyzed for SVOCs before and after the study. A summary of the SVE treatability study results are provided below.

- The SVE treatability study results demonstrated that the VOCs in the contaminated soil at the ACS Site can potentially be treated to the greater of the remediation levels or the analytical detection limits under the optimum conditions that exist at the bench-scale. Some SVOC removal occurred during SVE treatment without nutrient enhancement. However, the SVOCs which were initially detected in excess of their remediation levels were not reduced to below the remediation levels after treatment.
- For all three test runs, significant removal efficiencies were achieved for the VOCs. For compounds with initial concentrations in excess of site remediation levels, the final concentrations were reduced to below the greater of the remediation level or the analytical detection limit. However, residual levels of VOCs were detected in two of the treated soil samples. One test run, which had the highest initial concentrations, had low to mid parts per million concentrations of the aromatic hydrocarbons ethyl benzene, toluene, and xylene (ETX) remaining in the treated soil. The aromatic hydrocarbons were present at the highest initial concentrations of the measured VOCs, and are among the less volatile, and thus more difficult (i.e., have lower vapor pressures), of the VOCs subject to removal by SVE. Low to mid parts per billion concentrations of a few VOCs were detected in the treated soil for the low air flow rate test run. All of the measured VOCs were below the analytical detection limits for the third test run.
- Some SVOC reductions were observed based on the ending concentrations measured in the treated soil. The reduction in SVOC concentrations can be attributed either to volatilization, biological degradation, or analytical variances caused by the sampling of a potentially non-homogeneous soil matrix. However, SVOCs initially detected in excess of their respective remediation levels were not reduced to below the remediation levels after treatment. The final concentrations for isophorone, hexachlorobutadiene, pentachlorophenol, and bis(2-ethylhexyl) phthalate were above their respective remediation levels.
- Removal efficiencies for other SVOCs of interest with relatively low remediation levels, bis(2-chloroethyl) ether and carcinogenic PAHs in particular, could not be evaluated by the treatability study, because they were not detected in excess of their respective analytical detection



limits. Based on its vapor pressure, SVE removal potential for bis(2-chloroethyl) ether should be similar to naphthalene and isophorone, two compounds which were found in the treatability study samples. As was the case with isophorone, some reduction in bis(2-chloroethyl) ether would be expected to occur through volatilization and/or biological degradation. However, removal below the remediation level would not be expected to occur in areas where bis(2-chloroethyl) ether concentrations initially exceed its remediation level.

- Little to no reduction in carcinogenic PAH concentrations would be expected to occur as a result of SVE treatment based on their vapor pressures and resistance to biological degradation. Therefore, removal would not be expected to occur in areas where carcinogenic PAH concentrations initially exceed its remediation level.
- The total number of air pore volumes required to achieve greater than 90% VOC mass reduction was at the higher end of the 3,000 to 6,000 pore volume exchange range typical of bench-scale treatability studies. Tetrachloroethene would likely be a primary controlling compound for remediation purposes because of its relatively low remediation level, its high frequency of detection and initial concentrations, and lower volatility (i.e., slower removal rate by SVE). The aromatic hydrocarbons ethylbenzene, toluene, and xylene also had slower removal rates because of their lower volatility, but these compounds have higher remediation levels than tetrachloroethene.
- Other VOCs with relatively low remediation levels (e.g., carbon tetrachloride, vinyl chloride, 1,1,2-trichloroethane) were not tested, since they were not detected in the treatability study samples. It should be noted that these compounds did not have a high frequency of detection based on the RI data. Based on their vapor pressures, SVE removal potential for carbon tetrachloride, vinyl chloride, and 1,1,2-trichloroethane should be similar to trichloroethene and 1,1,1-trichloroethane, two compounds which were found in the treatability study samples. The treatability study results for trichloroethene and 1,1,1-trichloroethane demonstrate the ability of SVE treatment to potentially meet the respective remediation levels for carbon tetrachloride, vinyl chloride, and 1,1,2-trichloroethane under the optimum conditions that exist at the bench-scale.
- The initial concentrations for the VOCs and SVOCs are representative of the On-and Off-Site Areas, but are not representative of localized maximum concentrations measured during the RI.



- The analytical detection limits exceeded the remediation levels in one test run for the VOCs vinyl chloride, 1,1-dichloroethene, carbon tetrachloride, 1,2-dichloropropane, 1,1,2-trichloroethane, and 1,1,2,2-tetrachloroethane, as well as for the SVOCs bis(2-chloroethyl) ether, 2,6- and 2,4-dinitrotoluene, hexachlorobenzene, and carcinogenic PAHs. The higher analytical detection limits were either consistent with CLP protocol, or due to matrix interferences.

The following factors associated with the effectiveness and operation of a full-scale SVE system could not be evaluated as part of a bench-scale treatability study. These conditions will be evaluated during the RD/RA phases of this project.

- Slower removal rates and higher final concentrations are usually observed for full-scale SVE systems when compared against bench-scale treatability studies. Bench-scale SVE treatability tests represent optimum, best case conditions where there is direct and continuous contact of air with the contaminants. These conditions are usually not uniformly achievable throughout the entire treatment zone for full-scale systems. Subsurface geologic heterogeneities and obstructions and mass transfer limitations usually impact the contaminant removal rates and final concentrations which are achievable for full-scale SVE systems. When these conditions exist, diffusion instead of advection (i.e., volatilization by direct contact with air) becomes the primary contaminant removal mechanism. VOC removal by diffusion mechanisms is a slower process than advection.
- The actual starting concentrations for the more water soluble contaminants may be higher at the site than what was reflected in the treatability study samples and subsequent testing. The VOCs benzene, trichloroethene, acetone, and methyl ethyl ketone and the SVOC bis(2-chloroethyl) ether were detected at lower concentrations in the treatability study samples than their respective weighted average concentrations based on the RI data. The SVE treatability study, therefore, could not test the ability to treat benzene and bis(2-chloroethyl) ether to their relatively low remediation levels.
- Each of the above mentioned compounds are among the more soluble VOCs and SVOCs in water, and likely exist to a significant extent in the soil moisture. Because the treatability study samples were prepared by compositing soil cuttings using solid flight augers, the soil moisture levels and resulting concentrations of the more soluble VOCs and SVOCs may have been lower than actual weighted average conditions. Higher concentrations of the more soluble contaminants will likely be present at depth for treatment by the full-scale SVE system.





- The high soil moisture level at the Site will likely reduce the contaminant removal rates and increase the remediation timeframe. High moisture levels block air flow paths (i.e., reduced air porosity) and prevent direct contact with contaminants. Contaminants which dissolve into the aqueous phase are also slower and more difficult to remove by SVE.

### **BIOVENTING TREATABILITY STUDY**

A bioventing bench-scale treatability study was performed by Envirogen Inc. (Envirogen) on a reasonable worst case contaminated soil sample from the Off-Site Containment Area. The study included a nutrient amended column (i.e., bioventing), a non-amended column (i.e., SVE only), and an azide control (i.e., reduced biological activity SVE column). Approximately 3,000 air pore volumes were passed through the columns. The samples were analyzed for VOCs and SVOCs before and after the column studies. A detailed summary is provided below.

- Based on a comparison of the results for the control (i.e., azide) column versus the non-amended and nutrient amended columns, nutrient enhancement significantly increased the removal efficiencies for the SVOCs and moderately increased the removal efficiencies for the ETX compounds. The results of the bioventing tests demonstrate that most of the target non-chlorinated VOC and SVOC contaminants are subject to removal by biological degradation to varying degrees.
- Even though significant SVOC reductions occurred under enhanced bioventing conditions (i.e., nutrient enhanced column), SVOCs which were detected in excess of their respective remediation levels were not reduced to below the remediation levels. Isophorone and bis(2-ethylhexyl)phthalate had final concentrations in excess of their remediation levels in the nutrient enhanced column.
- The SVOC removal efficiencies were greater for the SVE treatability tests than for the analogous non-amended bioventing treatability test. This is likely due either to the higher mass of oxygen which was delivered during the SVE treatability tests (i.e., approximately 11,000 versus 3,000 air pore volumes) or analytical variances caused by the sampling of a potentially non-homogenous soil matrix.
- It appears that a significant portion of the acetone, 2-butanone, 4-methyl-2-pentanone, benzene, ethyl benzene, xylene, and toluene reductions can be attributed to biological degradation. This conclusion



is based on the mass balance calculations performed for the SVE treatability tests (i.e., a significant portion of the VOC mass cannot be accounted for by the exhaust gas measurements), as well as a comparison of the exhaust gas measurements for the SVE and bioventing treatability tests (i.e., the individual contaminant concentrations measured in the exhaust gas for the bioventing tests were lower).

- The initial concentrations for the VOCs and SVOCs were equivalent to those found in the SVE treatability test samples and can be considered representative of the weighted average concentrations for the Off-Site Area, but are not representative of localized maximum concentrations measured during the RI.
- The site conditions appear to be capable of supporting enhanced biological activity.

The following factors associated with the effectiveness and operation of a full-scale bioventing system could not be evaluated as part of a bench-scale treatability study. These conditions will likely have to be evaluated during the RD/RA phases of this project.

- Slower removal rates and higher final concentrations are usually observed for full-scale SVE and bioventing systems when compared against bench-scale treatability studies. Bench-scale SVE and bioventing tests represent optimum, best case conditions where there is direct and continuous contact of air and nutrients with the contaminants. These conditions are usually not uniformly achievable throughout the entire treatment zone for full-scale systems. Subsurface geologic heterogeneities and obstructions and nutrient transport mechanisms usually impact the ability to uniformly deliver oxygen and nutrients to all areas and depths of the treatment zone.
- The feasibility and cost effectiveness of various in-situ nutrient delivery systems would have to be evaluated. Surface spraying/irrigation and infiltration galleries are the primary methods of delivering nutrients to the unsaturated zone. The ability to effectively deliver nutrients to the unsaturated zone is typically limited to a relatively small and shallow source area.

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**TABLE 1**  
**SUMMARY OF BENCH SCALE PERFORMANCE - CANONIE LTTT**  
**OFF-SITE CONTAINMENT AREA**

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDIATION</u> <u>LEVEL (MG/KG)</u>
<b><u>VOCs</u></b>			
ACETONE	110	0.19	80
METHYLENE CHLORIDE	1,500	0.29	6.2
1,1 DICHLOROETHENE	30	0.0064	0.098
1,1 DICHLOROETHANE	100	ND (0.005)	77
CHLOROFORM	43	0.0036	9.5
1,2 DICHLOROETHANE	3,200	0.0084	0.64
2-BUTANONE	560	ND (0.1)	21
1,1,1 TRICHLOROETHANE	1,300	0.044	77
1,1,2 TRICHLOROETHANE	27	ND (0.005)	0.42
CIS-1,3-DICHLOROPROPENE	25	ND (0.005)	
TRICHLOROETHENE	3,700	0.03	5.3
DIBROMOCHLOROMETHANE	28	ND (0.005)	
BENZENE	490	0.023	1
CIS-1,3-DICHLOROPROPENE	22	ND (0.005)	
BROMOFORM	28	ND (0.005)	
TETRACHLOROETHENE	1,400	0.048	1.1
TOLUENE	2,200	0.034	167
CHLOROBENZENE	67	0.026	5
ETHYLBENZENE	870	0.027	43
STYRENE	420	0.014	1.7
XYLENES, TOTAL	3,700	ND (0.005)	867
<b><u>PCBs</u></b>			
1,2,3,4,5-PENTACHLOROBENZENE	77	ND (1)	2
<b><u>SVOCs</u></b>			
PHENOL	150	ND (0.33)	
2-METHYLPHENOL	10	ND (0.33)	
4-METHYLPHENOL	21	ND (0.33)	
ISOPHORONE	150	ND (0.33)	7.2
2,4-DIMETHYLPHENOL	10	ND (0.33)	
NAPHTHALENE	100	ND (0.33)	3
HEXACHLOROCYCLOPENTADIENE	17	ND (0.33)	0.36
2-METHYLNAPHTHALENE	64	ND (0.33)	
DIMETHYL PHTHALATE	12	ND (0.33)	
DIETHYL PHTHALATE	6.6	ND (0.33)	
PHENANTHRENE	3.3	ND (0.33)	
DI-N-BUTYL PHTHALATE	71	ND (0.33)	77
BUTYLBENZYL PHTHALATE	51	ND (0.33)	
BIS(2-ETHYLHEXYL)PHTHALATE	210	ND (0.33)	1.1

NOTE: Initial non-detects not listed

**TABLE 2**  
**SUMMARY OF BENCH SCALE PERFORMANCE - CANONIE LTTT**  
**OFF-SITE CONTAINMENT AREA (spiked)**

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDIALATION</u> <u>LEVEL (MG/KG)</u>	<u>WARZYN</u> <u>RESIDENTIAL</u> <u>STD. (MG/KG)</u>	<u>WARZYN</u> <u>INDUSTRIAL</u> <u>STD. (MG/KG)</u>
<b><u>VOCs</u></b>					
ACETONE	113	1.2	80	RLT	RLT
1,1 DICHLOROETHENE	103	ND (0.5)	0.098	3.5	0.38
1,2 DICHLOROETHANE	202	ND (0.5)	0.64	23	32
2-BUTANONE	91.4	ND (10)	21	NA	NA
1,1,1-TRICHLOROETHANE	1,110	ND (0.5)	77	NA	RLT
TRICHLOROETHENE	378	ND (0.5)	5.3	191	408
TETRACHLOROETHENE	874	ND (0.5)	1.1	41	157
TOLUENE	783	ND (0.5)	167	RLT	RLT
ETHYLBENZENE	146	ND (0.5)	43	RLT	RLT
XYLENES TOTAL	830	ND (0.5)	867	RLT	RLT
<b><u>PCBs</u></b>					
AROCHLOR 1248	150	ND(1)	2		
<b><u>SVOCs</u></b>					
PHENOL	15.4	ND(1.65)		RLT	RLT
NAPHTHALENE	45.8	ND(1.65)	3	RLT	RLT
ACENAPHTHALENE	1.04	ND(1.65)			
1-METHYLNAPHTHRENE	1.26	ND(1.65)			
DI-N-BUTYL PHTHALATE	33.7	ND(1.65)	77	RLT	RLT
BUTYLBENZYL PHTHALATE	9.4	ND(1.65)			
BIS (2-ETHYLHEXYL) PHTHALATE	162	ND(1.65)	1.1	144	537
CHRYSENE	7.25	ND(1.65)		75	306

NOTE: Initial non-detects not listed

RLT= Relatively low toxicity

TABLE 3  
SUMMARY OF BENCH SCALE PERFORMANCE - CANONIE LTTT  
ON-SITE CONTAINMENT AREA (spiked)

<u>PARAMETER</u>	<u>INITIAL (MG/KG)</u>	<u>TREATED (MG/KG)</u>	<u>ROD REMEDICATION LEVEL (MG/KG)</u>
<u>VOCs</u>			
CHLOROMETHANE	6,340	ND (1)	
ACETONE	86,600	0.58	80
2-BUTANONE	6,000	ND(10)	21
1,1,1-TRICHLOROETHANE	19,700	8.7	77
TRICHLOROETHENE	134	ND (0.5)	5.3
BENZENE	5,110	ND (0.5)	1
1,2-DICHLOROETHENE	3,900	ND (0.5)	1.1
TOLUENE	353	ND (0.5)	167
ETHYLBENZENE	159	ND (0.5)	43
XYLENES TOTAL	1,960	ND (0.5)	867
<u>PCBs</u>			
AROCHLOR 1248	72.3	ND (1)	2
<u>SVOCs</u>			
ISOPHORONE	225	ND (0.33)	7.2
NAPHTHALENE	13	ND (0.33)	3

NOTE: Initial non-detects not listed

**TABLE 4**  
**SUMMARY OF BENCH SCALE PERFORMANCE - ENVIROGEN BIOVENTING**  
**OFF-SITE CONTAINMENT AREA (nutrient amended)**

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDIALATION</u> <u>LEVEL (MG/KG)</u>
<b><u>VOCs</u></b>			
4-METHYL-2-PENTANONE	71	<9	21
TETRACHLOROTHENE	210	<b>26</b>	1.1
ETHYLBENZENE	580	<9	43
XYLENES TOTAL	3,280	328	867
TOLUENE	990	<9	167
<b><u>SVOCs</u></b>			
ISOPHORONE	130	<b>50</b>	7.2
NAPHTHALENE	230	140	3
BIS (2-ETHYLHEXYL) PHTHALA	610	<b>70</b>	1.1
DI-N-BUTYLPHTHALATE	350	55	77

NOTE: Initial non-detects not listed

**TABLE 5**  
**SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE**  
**TREATMENT LAGOON AREA (low air flowrate)**

<u>Parameter</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDICATION</u> <u>LEVEL. (MG/KG)</u>
<b><u>VOCs</u></b>			
ACETONE	37	<0.028	80
2-BUTANONE	20	<0.028	21
1,1,1-TRICHLOROETHANE	18	<0.028	77
4-METHYL-2-PENTANONE	40	<0.028	21
TOLUENE	86	<0.028	167
TETRACHLOROETHENE	18	<0.028	1.1
ETHYLBENZENE	56	0.044	43
TOTAL XYLENE	262	0.43	867

IE: Initial non-detects not listed

**TABLE 6**  
**SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE**  
**TREATMENT LAGOON AREA**

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED REMEDIATION</u> <u>(MG/KG)</u>	<u>ROD</u> <u>LEVEL (MG/KG)</u>	<u>WARZYN</u> <u>RESIDENTIAL</u> <u>STD. (MG/KG)</u>	<u>WARZYN</u> <u>INDUSTRIAL</u> <u>STD. (MG/KG)</u>
<b><u>VOCs</u></b>					
ACETONE	27	<0.006	80	RLT	RLT
2-BUTANONE	23	<0.006	21	NA	NA
1,1,1-TRICHLOROETHANE	40	<0.006	77		NA
TRICHLOROETHENE	14	<0.006	5.3	191	408
4-METHYL-2-PENTANONE	48	<0.006	21	NA	RLT
TOLUENE	140	<0.006	167	RLT	RLT
TETRACHLOROETHENE	30	<0.006	1.1	41	157
ETHYLBENZENE	86	<0.006	43	RLT	RLT
TOTAL XYLENE	420	<0.006	867	RLT	RLT
<b><u>SVOCs</u></b>					
BIS (2-CHLOROETHYL)ETHER	2	<0.4	0.027	2	8
ISOPHORONE	23	9.6	7.2	536	2,179
NAPHTHALENE	10	0.6	3	RLT	RLT
HEXACHLOROBUTADIENE	2	2	0.36	28	110
PENTACHLOROPHENOL	<0.9	5.4	0.43	19	81
BIS (2-ETHYLHEXYL)PHTHALATE	76	35	1.1	144	537
DI-N-BUTYLPHTHALATE	15	8.8	77	RLT	RLT

TE: Initial non-detects not listed

RLT= Relatively low toxicity



**TABLE 7**  
**SUMMARY OF BENCH SCALE PERFORMANCE - VAPEX SVE**  
**OFF-SITE CONTAINMENT AREA**

<u>PARAMETER</u>	<u>INITIAL</u> <u>(MG/KG)</u>	<u>TREATED</u> <u>(MG/KG)</u>	<u>ROD</u> <u>REMEDICATION</u> <u>LEVEL (MG/KG)</u>
<u>VOCs</u>			
1,1,1-TRICHLOROETHANE	57	<0.78	77
4-METHYL-2-PENTANONE	62	<0.78	21
TOLUENE	1,200	1.6	167
TETRACHLOROETHENE	220	<0.78	1.1
ETHYLBENZENE	440	3.4	43
TOTAL XYLENE	2,490	26	867

TE: Initial non-detects not listed